P161 IMPROVED IMPACT OF ATMOSPHERIC INFRARED SOUNDER (AIRS) RADIANCE ASSIMILATION IN NUMERICAL WEATHER PREDICTION

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1. INTRODUCTION

- For over 6 years, AIRS radiances have been assimilated operationally into National (*e.g.* EMC; Le Marshall *et al.* 2006)) and International (*e.g.* ECMWF; McNally *et al.* 2006), operational centers; assimilated in the North American Mesoscale (NAM) since 2008
- Due partly to data latency and operational constraints, hyperspectral radiance assimilation has had less impact on the Gridpoint Statistical Interpolation (GSI) system used in the NAM and GFS
- Objective of this project is to use AIRS retrieved profiles as a proxy for the AIRS radiances in situations where AIRS radiances are unable to be assimilated in the current operational system by evaluating location and magnitude of analysis increments

2. BACKGROUND ON AIRS DATA ASSIMILATION

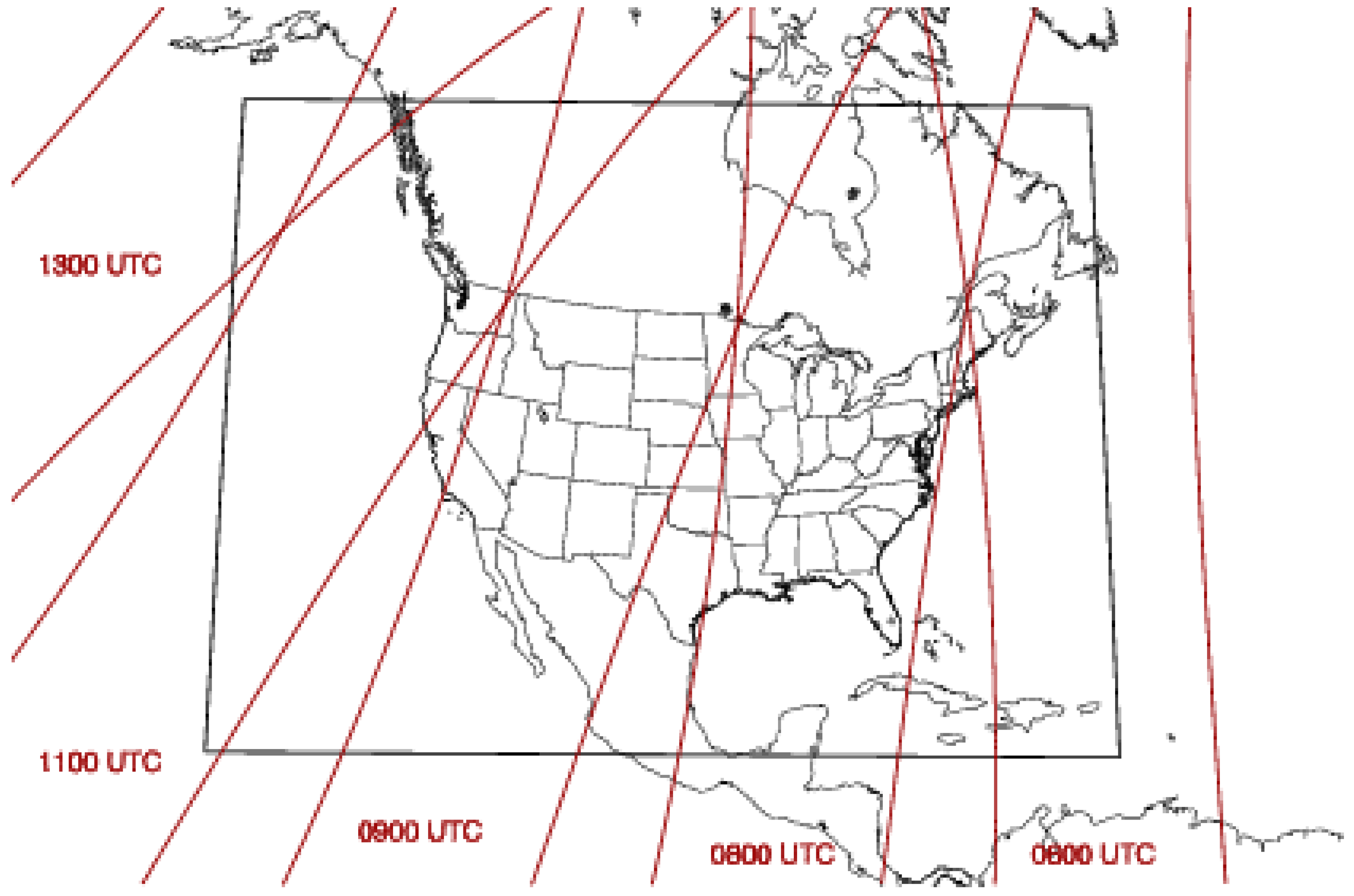

Fig. 1. Typical locations and overpass times for early morning overpass of AIRS satellite

2.1. AIRS Radiance Assimilation

- Model background is converted to radiance space prior to assimilation using the Community Radiative Transfer Model (CRTM), but requires large computational resources leading to data reduction/subsampling
- AIRS assimilation currently limited to only cloud-free pixels as determined by 5-tier cloud check (Goldberg et al. 2002)
- Near-surface pixels over land may be removed due to surface emissivity
- Observation errors and channels assimilated in this study match the operational NAM (Fig. 2)

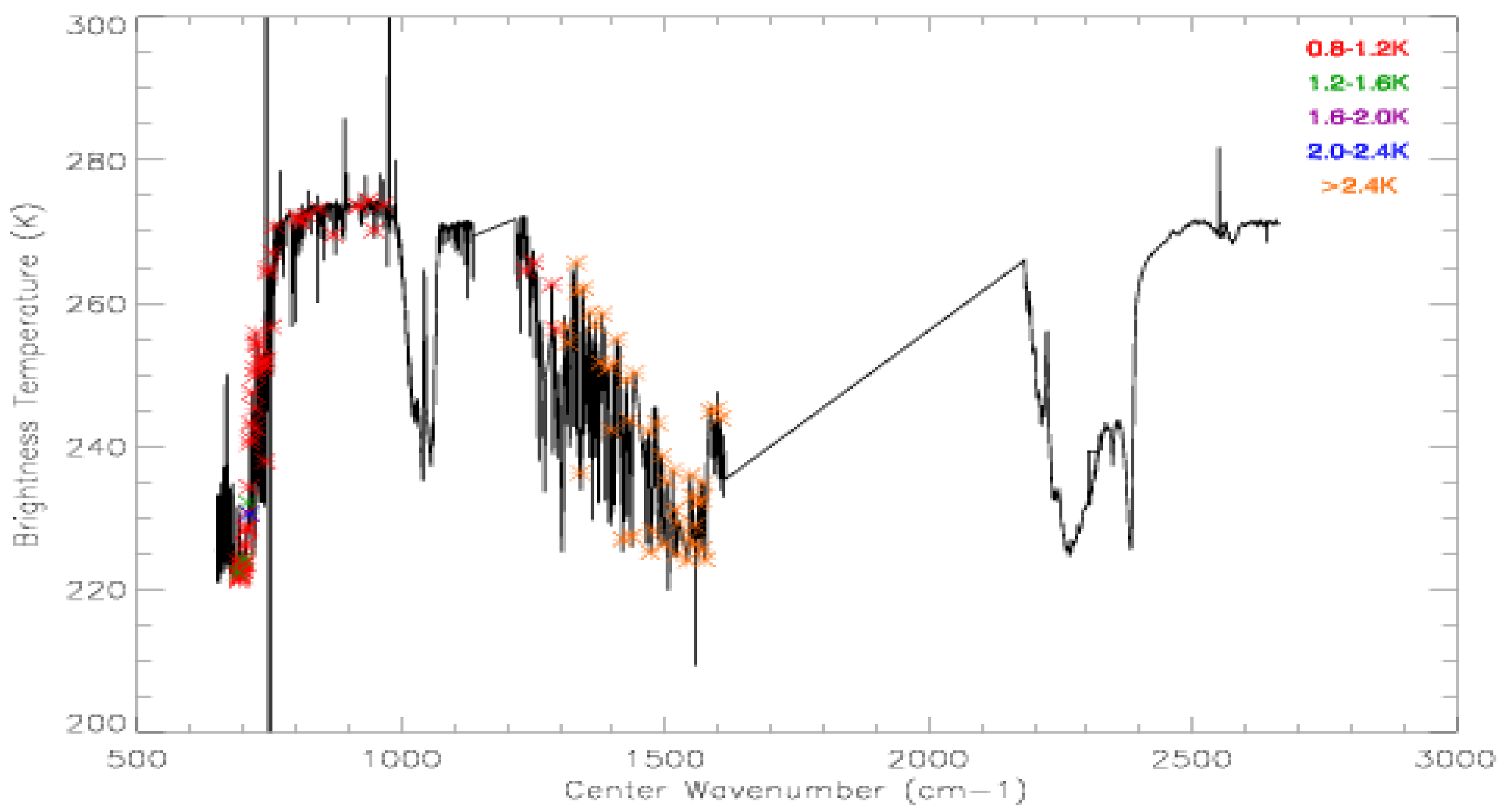

Fig. 2. AIRS spectrum with colored points representing the observation error of each channel assimilated in this study

2.2. AIRS Profile Assimilation

- Radiative transfer model is run outside of data assimilation system to retrieve temperature and moisture soundings
- Using V5 AIRS Science Team retrieved profiles
- Location matching performed to only assimilate AIRS profiles from granules that were available in real-time NAM system; observation locations within the granules will vary based on data removed by radiance assimilation but retained in profile assimilation (see Fig. 6)
- Although not optimal, retrieved profiles are currently assimilated into GSI as RAOBs with observation errors identical to RAOBs (Fig. 3)

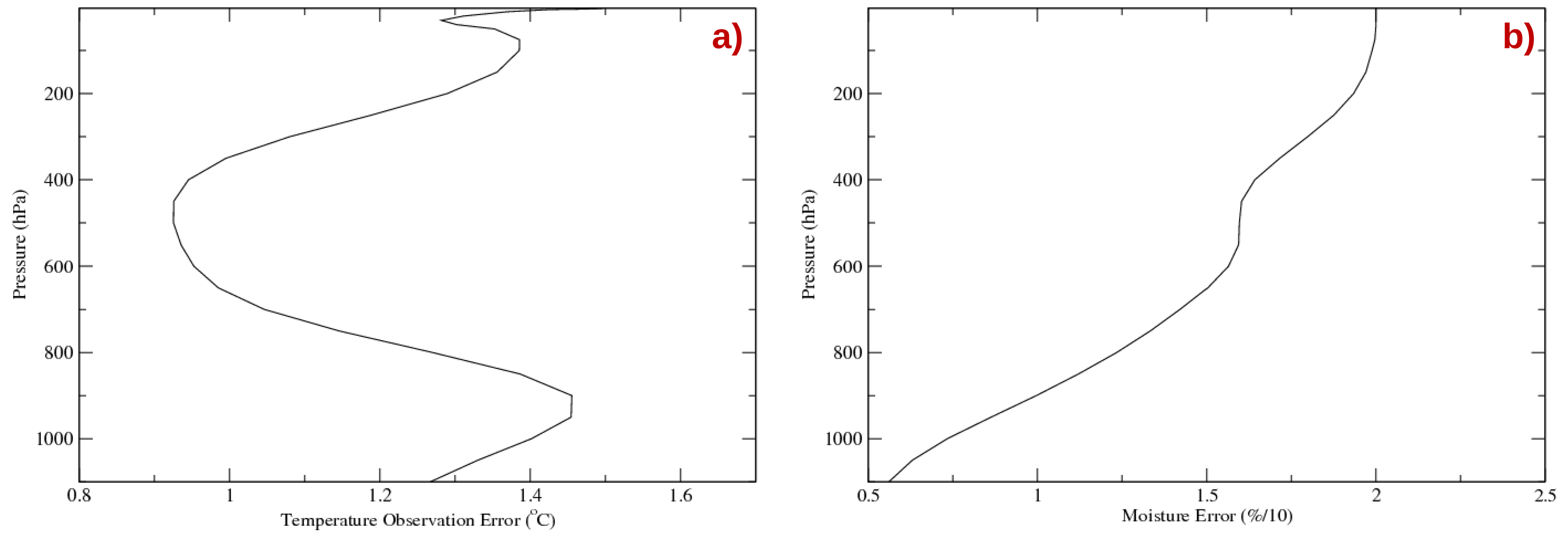

Fig. 3. Observation errors for AIRS retrieved profiles for this study for a) temperature (°C) and b) moisture (%/10)

3. MIMICKING OPERATIONAL NAM

- Regional model is used here to better pinpoint specific locations of analysis differences between radiance and profile assimilation and track back to radiance rejection by cloud, surface, or subsampling
- This study uses 12-km (NAM-218 grid) with WRF-NMM, operational physics options, and "pre-cycling methodology whereby the previous 12 hours of data are assimilated (Fig. 4) to as closely as possible emulate the operational system

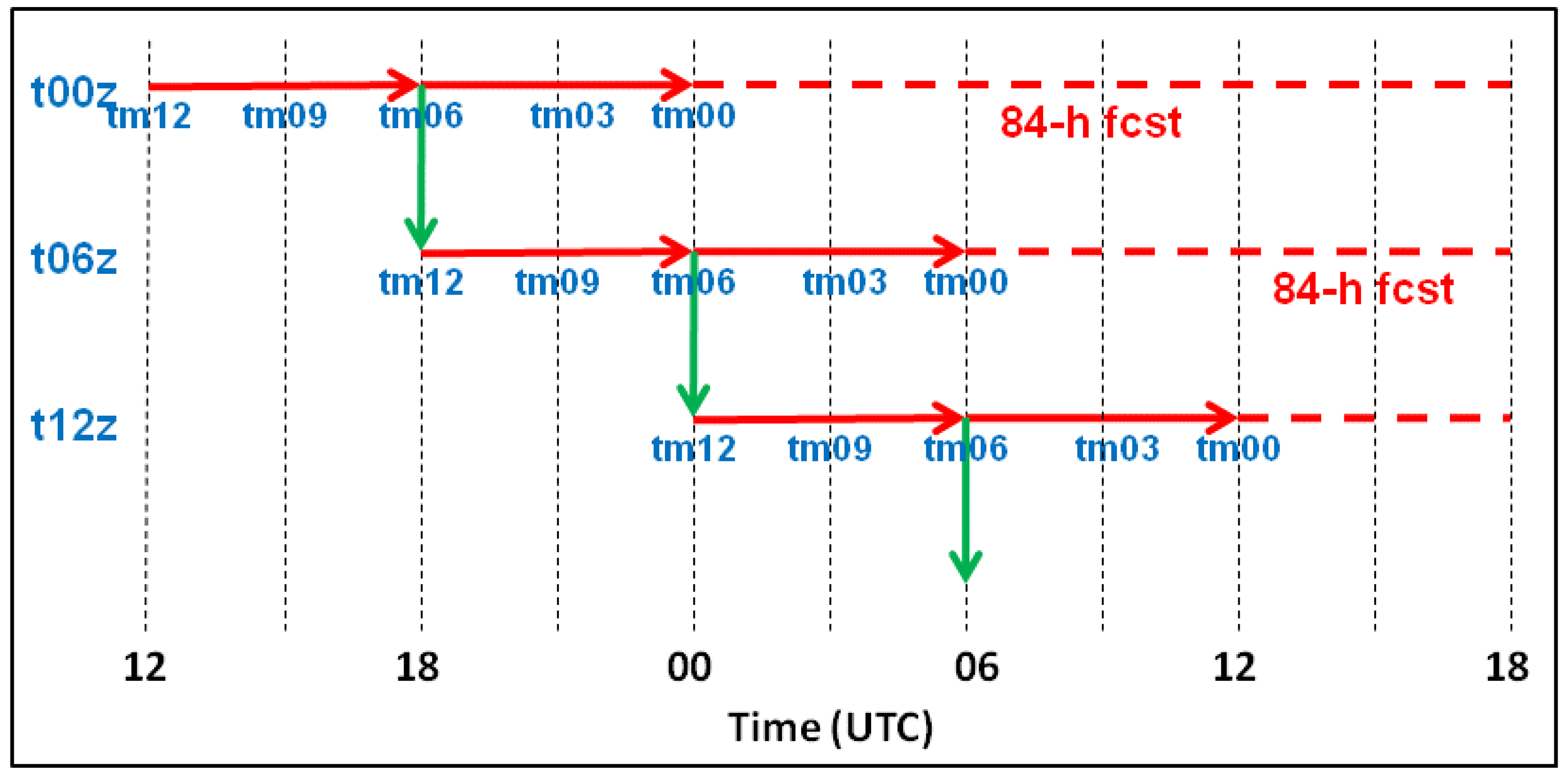

Fig. 4. Observation errors for AIRS retrieved profiles for this study for a) temperature (°C) and b) moisture (%/10)

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Le Marshall, J., *et al.*, 2006: Improving global analysis and forecasting with AIRS, *Bull. Amer. Meteor. Soc.*, **87(7)**, 891-894.

McNally, A. P., P. D. Watts, J. A. Smith, R. Engelen, G. A. Kelly, J. N. Thépaut, and M. Matricardi, 2006. The assimilation of AIRS radiance data at ECMWF. *Quart. J. Roy. Meteor. Soc.*, **132**, 935-957.

4. DETERMINING GSI'S EFFECTIVENESS IN DETECTING CLOUDS, HANDLING SURFACE EMISSIVITY DETECTION, AND SUBSAMPLING

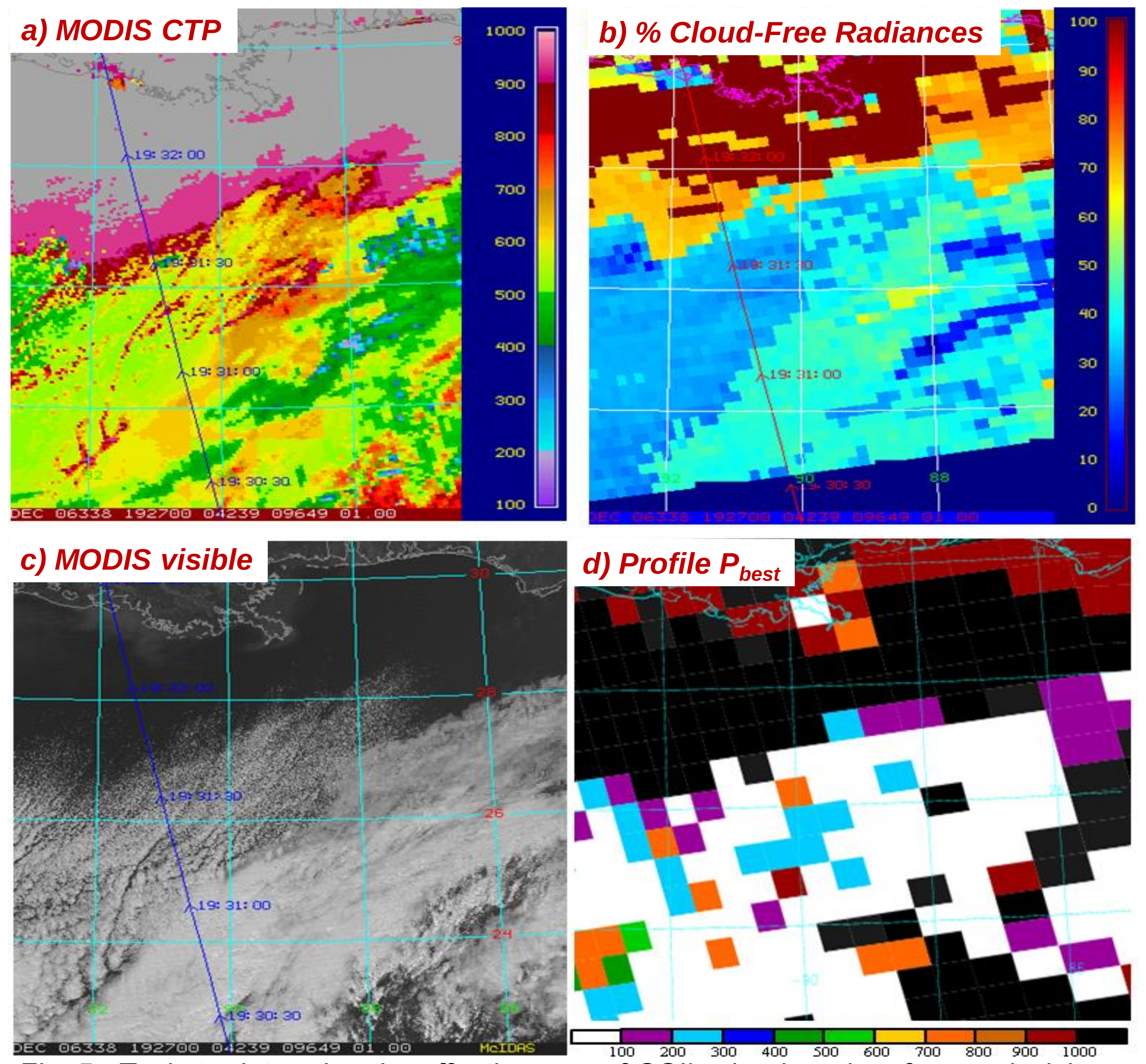

Fig. 5. Tools to determine the effectiveness of GSI's cloud and surface emissivity detection algorithms for a challenging day with multiple cloud types

- Patterns of the percent of cloud free radiances to be assimilated matches well with CTP and visible imagery from MODIS (Fig. 5a,b)
- Quantitative assessment of GSI-determined CTP for radiance assimilation to be compared to MODIS CTP, AIRS profile CTP (not shown), and AIRS P_{best} QC variable (Fig. 5d)
- Diagnostic statements added within GSI source code determine which radiances pass the multiple clear-radiance checks and are actively assimilated at which pressure levels (see Fig. 6b for example)
- Operationally, the locations of these radiances are thinned to 120 km and only clear-sky radiances are assimilated (compare convective clouds over eastern CO and western KS in Fig. 6a with location of white spaces in swath in Fig. 6b) leaving large gaps around cloud features that are important for capturing storm dynamics
- Use of profiles at full spatial with quality control to determine highest quality data fills in gaps around the convective cloud feature and may allow for greater impact in meteorologically significant regions
- Model simulations are ongoing using NASA Center for Climate Simulations (NCCS) Joint Center in a Big Box (JIBB) supercomputing system
- Once simulations are completed, location and magnitude of analysis increments will be compared to the imagery tools shown in Figure 5

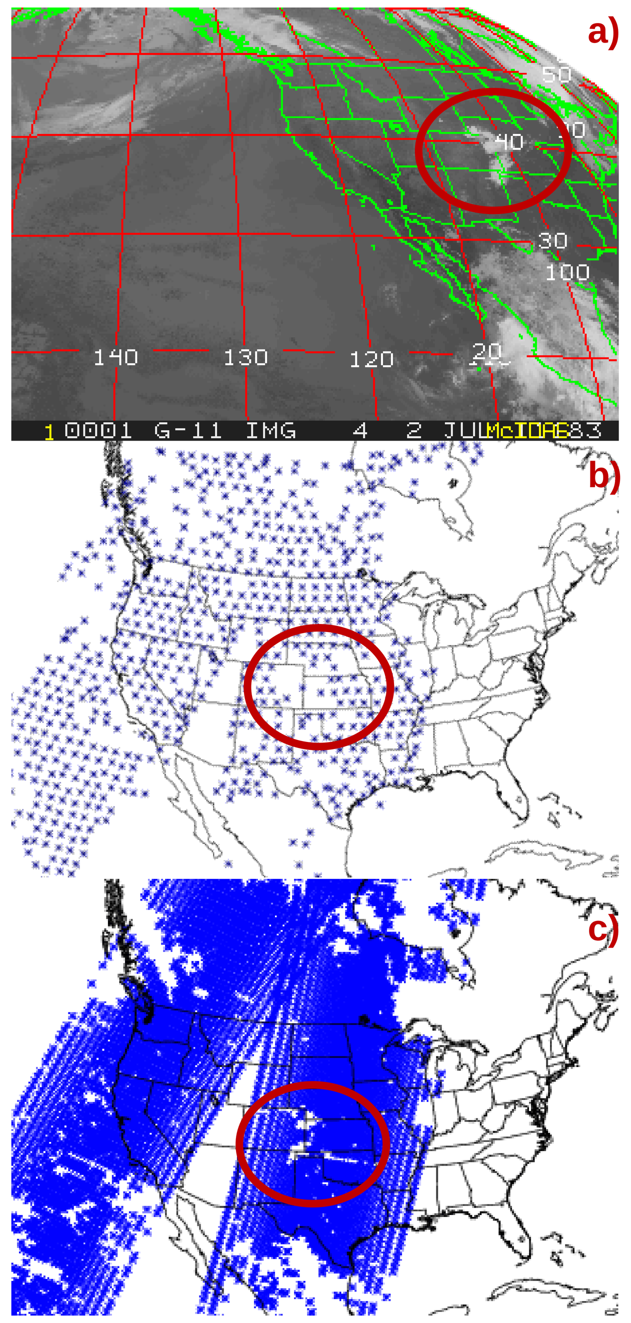

Fig. 6. Isolated convection on 2 July 2011 at 0900 UTC shown in a) GOES-West imagery and AIRS b) radiances and c) profiles assimilated below 400 hPa

5. SUMMARY

- Increased impact of AIRS radiances may be achieved by enhancing the selection of assimilated radiances within GSI
- Using retrieved profiles to show regions where information from AIRS data could impact radiance assimilation may result in additional impact from radiance observations
- Results of this regional study can be applied to the global system